IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Application of: Group Art Unit: 1775

Applicant: Andrew Jeremiah Burns, et al. Examiner: Elizabeth D. Ivey

Serial No.: 10/816,739 Atty. Docket: 2003P05056US

Filed: 04/02/2004

Title: THERMAL BARRIER COATING HAVING NANO SCALE FEATURES

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Declaration of Brij B. Seth Under 37 CFR 1.132

1. I, Brij B. Seth, a citizen of the United States of America, hereby declare and state as follows;

2. I am currently employed as an engineering consultant to Siemens Power Generation, Inc. I was formerly employed by Siemens Power Generation and its predecessor corporations, Siemens Westinghouse Power Corporation and Westinghouse Electric Corporation, for approximately thirty five years. At the time of my retirement from Siemens Westinghouse Power Generation, I held the position of Sector Head of the Materials Engineering Department of the Gas Turbine Division.

3. I have over forty years experience working in the field of advanced materials development.

4. I am a named inventor on over a dozen United States patents in the field of materials technology and gas turbine component applications for such materials.

5. I received a Bachelor of Science in Physics/Chemistry/Math from University of Rajasthan (India); a Bachelor of Engineering in Metallurgy from the Indian Institute of Science (Bangalore, India); a Master of Applied Science in

Metallurgy and a Ph.D. in Metallurgy from the University of Toronto (Canada). I am a Fellow of the American Society of Metals and have authored approximately 45 technical publications.

6. I am familiar with the above-cited patent application.

7. Upon information and belief, I understand that the USPTO Examiner has rejected claims of the above-cited patent application as being anticipated or obvious over prior art patents 6,689,487 (hereinafter Murphy), 6,544,665 (hereinafter Rigney), and 6,677,064 (hereinafter Subramanian).

8. I disagree with the Examiner's assertion that the cited prior art patents inherently disclose the claimed aspects of the present invention.

9. With regard to the Murphy patent and claim 2 of the present application, I disagree with the Examiner's assertion that a mixed oxide layer would inherently be disposed between the thermally grown oxide layer and the layer of ceramic oxide insulating material and would be formed of particles having a size range of less than 100 nm. Murphy's invention is focused on lowering the thermal conductivity of electron beam physical vapor deposited (EBPVD) columnar grained ceramic. Consequently, Murphy contains no teaching of the presence of a mixed oxide layer, and there no teaching of its thickness, its composition or any characteristic of particle size. The layer of ceramic oxide insulating material of Murphy is deposited by EBPVD over a thermally grown alumina layer 28 formed on the bond coat 24. Even when Murphy mentions the doping of the alumina layer (28) with other elements, there is no mention of particle characteristics. Neither the EBPVD process nor the bond coat oxidation process involves the deposition of particles of any size, and no such mixed oxide layer would be inherently formed before, during or after the EBPVD process.

10. With regard to the Murphy patent and claim 5 of the present application, I disagree with the Examiner's assertion that a ratio of average thickness of a mixed oxide layer to average thickness of the thermally grown oxide layer is between 0.333 and 0.1667. As discussed above in Paragraph 9,

there is no mixed oxide layer formed in the device/process of Murphy. Thus, any comparison of thicknesses to a non-existent mixed oxide layer is meaningless.

11. With regard to the Murphy patent and claims 6 and 7 of the present application, I disagree with the Examiner's assertion that a plurality of alumina projections would inherently extend across an interface from a mixed oxide layer into the insulating material layer of the coating of Murphy. As discussed above in Paragraph 9, there is no mixed oxide layer formed in the device/process of Murphy. Thus, it is impossible for the coating of Murphy to inherently disclose the claimed alumina projections. Since no alumina projections exist in Murphy, it is impossible for Murphy inherently to describe that such alumina projections have an aspect ratio of between 5 and 50.

12. With regard to the Murphy patent and claim 8 of the present application, I disagree with the Examiner's assertion that columnar grains having cross-sectional widths in the range of 1-5 nm would inherently be formed within individual splats of ceramic insulating material deposited by an air plasma spray process. Murphy discloses that ceramic thermal barrier coating layer 30 is deposited by an electron beam vapor deposition (EBPVD) process (column 5, lines 19-22). An EBPVD process produces no splats of material. Thus Murphy teaches away from the limitations of claim 8.

13. With regard to the Murphy patent and claims 9 and 10 of the present application, I disagree with the Examiner's assertion that the coating of Murphy inherently describes primary columnar grains having secondary columnar grains extending laterally from the primary columnar grains and having lengths in the range of 5-80 nm, or that such secondary columnar grains would have an as-deposited tip with a radius of curvature of less than 0.1 nm. Known prior art EBPVD processes do not inherently produce such nano-sized columnar grains or such a small secondary grain tip radius. The EBPVD processing parameters, such as the partial pressure of gasses within the EB-coating chamber, the ingot feed rate, the substrate temperature, the substrate rotation rate and the flux density of the vapor species, would have to be closely controlled to achieve such a result. Murphy describes an exemplary embodiment at column

7, lines 35-55 wherein the distance between adjacent secondary columnar grains along a respective primary columnar grain is about 6 to 10 microns. As may be appreciated with this dimension in mind, the embodiment illustrated by Murphy in FIGs. 3A-3D is clearly not of the nano-scale of claims 9 and 10 of the present invention.

14. With regard to the Murphy patent and claim 11 of the present application, I disagree with the Examiner's assertion that the coating of Murphy would inherently include a region of features maintaining a Specific Surface Area of at least 20,000 cm^2/cm^3 after exposure of the material to a temperature of 1,200 °C. for 1,000 hours. The embodiment illustrated in FIGs. 3A-3D contains columns of a scale that would fail to provide such a large surface area even in the as-deposited condition, and the Specific Surface Area would only decrease with exposure to elevated temperature.

15. With regard to the Rigney patent and claim 2 of the present application, I disagree with the Examiner's assertion that the coating of Rigney inherently discloses a mixed oxide layer formed of mixed oxide particles having a size range of less than 100 nm disposed between a thermally grown oxide (TGO) layer and a layer of ceramic oxide insulating material. The invention deals only with dispersing alumina particle in the ceramic to (a) chemically getter other impurities in ceramic and (b) pin the grains and pore boundaries of the ceramic. Rigney does not contemplate or teach the presence of mixed oxide between TGO and ceramic, and as such, Rigney can not have the intent to achieve specific characteristics of the mixed oxides of the above-cited invention. The nano-sized precipitates 34 of Rigney are contained within the layer of ceramic oxide insulating material. No mixed oxide layer is inherently formed between a thermally grown oxide layer and a layer of ceramic oxide insulating material in the coating of Rigney.

16. With regard to the Rigney patent and claim 5 of the present application, I disagree with the Examiner's assertion that a ratio of average thickness of a mixed oxide layer to average thickness of the thermally grown oxide layer is between 0.333 and 0.1667. As discussed above in Paragraph 15,

there is no mixed oxide layer formed in the device/process of Rigney. Thus, any comparison of thicknesses to a non-existent mixed oxide layer is meaningless.

17. With regard to the Rigney patent and claims 6 and 7 of the present application, I disagree with the Examiner's assertion that a plurality of alumina projections would inherently extend across an interface from a mixed oxide layer into the insulating material layer of the coating of Rigney. As discussed above in Paragraph 15, there is no mixed oxide layer formed in the device/process of Rigney. Thus, it is impossible for the coating of Rigney to inherently disclose the claimed alumina projections. Since no alumina projections exist in Rigney, it is impossible for Rigney inherently to describe that such alumina projections have an aspect ratio of between 5 and 50.

18. With regard to the Rigney patent and claim 8 of the present application, I disagree with the Examiner's assertion that columnar grains having cross-sectional widths in the range of 1-5 nm would inherently be formed within individual splats of ceramic insulating material deposited by an air plasma spray process. Air plasma spray typically does not result in columnar grains within the splats, and particularly not with nano-sized columnar grains. Such nano-sized features would be achieved only with special control of deposition parameters such as the size of the powder used, the temperature of the substrate, the cooling rate of the deposition coating, and/or post deposition heat treatments.

19. With regard to the Subramanian patent and claims 6 and 7of the present application, I disagree with the Examiner's assertion that a plurality of alumina projections would inherently extend across an interface from a mixed oxide layer into the insulating material layer of the coating of Subramanian, and that such projections would have a cross-sectional lineal density of between 1 and 10 projections per 200 nm, and that such projections would have an aspect ratio of between 5 and 50. Subramanian deals with in-situ formation of various multi-phase ceramic coatings. Subramanian does not inherently reflect on mixed oxides and their geometric characteristics. Subramanian discloses a typical bond coat 24 having a grown oxide layer 26 and a thermal barrier coating 20. No mixed oxide layer would inherently be formed between the oxide layer 26

and the thermal barrier coating 20. Thus, it is impossible for Subramanian to describe inherently any alumina projections extending from a non-existent mixed oxide layer. Furthermore, to discuss the density and aspect ratio of a non-existent projection is meaningless.

20. All statements made herein of my own knowledge are true, and all statements made of information and beliefs are believed true. I acknowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By: Brij B. Seth Aug. 7, 2006

Brij B Seth Date